AD NUMBER

AD869315

NEW LIMITATION CHANGE

TO

Approved for public release, distribution unlimited

FROM

Distribution authorized to U.S. Gov't. agencies and their contractors; Administrative/Operational use; Apr 1970. Other requests shall be referred to Picatinny Arsenal, Dover NJ.

AUTHORITY

USAPA ltr, 11 Feb 1971

AD869315

AD ____________

COPY NO. 49

TECHNICAL REPORT 4052

HYGROSCOPICITY OF AMMONIUM NITRATE SAMPLES

JOEL HARRIS

APRIL 1970

PICATINNY ARSENAL
DOVER, NEW JERSEY

53

ACCESSION for	
CFSTI	WHITE SECTION ☐
DDC	BUFF SECTION ☑
UNANNOUNCED	☐
JUSTIFICATION	
BY	
DISTRIBUTION/AVAILABILITY CODES	
DIST.	AVAIL. and/or SPECIAL
2	

The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

DISPOSITION

Destroy this report when no longer needed. Do not return to the originator.

TECHNICAL REPORT 4052

HYGROSCOPICITY
OF
AMMONIUM NITRATE SAMPLES

JOEL HARRIS

APRIL 1970

AMMUNITION ENGINEERING DIRECTORATE
PICATINNY ARSENAL
DOVER, NEW JERSEY

TABLE OF CONTENTS

Section	Page
ACKNOWLEDGMENT	(ii)
SUMMARY	1
CONCLUSIONS	1
RECOMMENDATIONS	3
BACKGROUND	3
RESULTS	5
DISCUSSION	
Two Tests for Hygroscopicity: Static and Dynamic	7
Experimental Procedure	9
REFERENCE	11
APPENDICES	
A. Tables	13
B. Figures	19
TABLE OF DISTRIBUTION	37
ABSTRACT DATA	41

ACKNOWLEDGMENT

The author is grateful for the assistance of Gilbert G. Murray of Feltman Research Laboratories who conducted all the static hygroscopicity tests.

SUMMARY

Samples of ammonium nitrate were tested by the AED's Artillery Ammunition Laboratory for hygroscopicity at relative humidity (RH) levels of 60%, 70%, 80%, 90% and 95% and between 28°-30°C. Most of the sample of ammonium nitrate were coated; some were manufactured by a process producing prills; clay material was added in two cases. The results indicated that the ammonium nitrate which contained the least amount of impurities or additives also was the least hygroscopic.

CONCLUSIONS

An increase in the purity of ammonium nitrate causes a decrease in the hygroscopicity.

The addition of insoluble additives did not diminish the hygroscopicity of ammonium nitrate.

RECOMMENDATIONS

A careful statistically designed test should be conducted in a room where conditions could be accurately monitored and air movements could be controlled to simulate those in a loading plant. Weighings could then be made on perfectly dried ammonium nitrate samples without disturbing the equilibrium conditions. The exact hygroscopicity of each sample simulated to loading plant conditions could then be determined.

Ammonium nitrate of high purity should be considered for use in explosives to minimize hygroscopicity and extend shelf life of explosives.

BACKGROUND

Ammonium nitrate is a component in many explosive system, but a disadvantage in its use is its hygroscopicity. To extend the shelf life of explosives containing ammonium nitrate, it is important to minimize its hygroscopicity.

The types of ammonium nitrate tested consisted of high purity reagent grade, a less pure type which meets government specification, and three different types of phase stabilized prills. The prills consist of small balls of ammonium nitrate coated with a water insoluble material. In addition, two types of insoluble clays were physically added to the specification grade ammonium nitrate and tested. The specification requirements for the ammonium nitrates tested are in Table 4. The purpose of these tests was to determine which of the various types of ammonium nitrate considered for use in explosives would be the least hygroscopic.

RESULTS

This report deals with the rate of moisture gain and loss of ammonium nitrate samples. Table 1 and 3 contain data from a static test (samples in a controlled humidity dessicator) in which the percent hygroscopicity and percent dehydration are listed. Data of the hygroscopicity of ammonium nitrate from Table 1 are shown in Figures 1-3 for 0-6-1/2 hours and in Figures 4-7 for 0-24 hours. Table 2 contains the percent hygroscopicity data from a dynamic test in a chamber in which the desired humidity was maintained by blowers moving the moisture across the chamber and across the ammonium nitrate samples. This data is graphed and shown in Figures 8-10. Graphs of the hygroscopicity data from the static test listed in Table 3 are shown in Figures 11-15.

The graphs of the dehydration data in Table 1 are shown in Figure 16 and the same data from Table 3 is shown in Figure 17. Table 4 contains the available data on the chemical composition of each ammonium nitrate sample.

DISCUSSION

Two Tests for Hygroscopicity: Static and Dynamic

Two types of tests were used to determine the hygroscopicity of ammonium nitrate for use as a component in high explosives. Test 1 consisted of small cups filled with ammonium nitrate samples which were placed in dessicators kept at a constant humidity and 30°C. A closed system was thus established with little air movement. This test may be considered a static test depending on the ability of ammonium nitrate to attract water molecules. Test 2 may be considered a dynamic test since a current of steam and air was continuously passed across the samples. The advantage of the dynamic test was that samples could be weighed without opening a dessicator and disturbing the equilibrium conditions. Thus the dynamic test could be useful for determining hygroscopicity for periods from 0-120 minutes which would not be feasible with the static test.

A third test consisted of drying the wet samples for short periods in a 100°C oven. This will be considered a dehydration test or a determination of drying time for ammonium nitrate samples at 100°C. At RH of 60%, 70%, 80%, 90% and 95% and 30°C, six samples of ammonium nitrate were tested for hygroscopicity in small cups placed within dessicators. For the times shown in Table 1 of 2-1/2 to 24 hours, specification grade ammonium nitrate was less hygroscopic than any of the other types. The one exception noted was that from 6-24 hours at 95% RH, Mississippi Ground Prills was the least hygroscopic material. The order of least hygroscopicity overall humidity levels for this static test was (Figures 1-7):

1. Specification Grade
2. Ketona Prills
3. Mississippi Ground Prills
4. Specification Grade with 0.6% Microcell E.
5. Gulf Prills
6. Specification Grade with 1.3% AC-10 Clay.

PRECEDING PAGE BLANK

The same samples were tested from 0-2 hours in a humidity chamber. The first test was begun at 94% RH which slowly decreased over the two-hour test period to 87%. The temperature was constant at 28°C. Considering only the most hygroscopic of duplicate two-gram samples tested, the following order was established for least hygroscopicity at 87-94% (Table 2 and Figure 10):

1. Specification Grade with 1.3% AC-10 Clay.
2. Specification Grade with 0.6% Microcell E.
3. Mississippi Ground Prills
4. Specification Grade
5. Ketona Prills
6. Gulf Prills

A second dynamic test was conducted at 84% RH which decreased to 76% over a two-hour period at a constant 28°C. The following order was established for the most hygroscopic of duplicate two-gram samples (Table 2 and Figure 8 and 9) in order of least hygroscopicity:

1. Ketona Prills
2. Specification Grade
3. Mississippi Ground Prills
4. Gulf Prills
5. Specification Grade plus 1.3% AC-10 Clay.
6. Specification Grade plus Microcell E.

Before all these samples were obtained, a static test was performed by FRL on Specification Grade, Ketona Prills and Fisher Reagent Grade Ammonium Nitrate. These tests were performed like the above static test but for a longer period. The conditions of the test were RH 60-95%, temperature 30°C, time 163 hours. Fisher Reagent Grade was slightly less hygroscopic than was Specification Grade at 60%, 70%, 90% and 95%. The hygroscopicity of Specification Grade unaccountably increased more than that of the other two as the humidity level increased to 90% and 95% (Table 3, Figures 11-15).

Dehydration of the six samples in the first laboratory test at 100°C showed that Gulf Oil Prills dehydrated fastest and Ketona Prills the slowest (Table 1 and Figure 17). The following order was established for quickest dehydration:

1. Gulf Prills
2. Specification Grade with 1.3% AC-10 Clay.
3. Specification Grade
4. Specification Grade with 0.6% Microcell E.
5. Mississippi Ground Prills
6. Ketona High Density Prills

Dehydration of the samples from the earlier laboratory test showed that Fisher Reagent Grade ammonium nitrate dehydrated much quicker than did Specification Grade and Ketona Prills (Figure 17 and Table 3). All the data indicated that wet ammonium nitrate dehydrates in 2-4 hours at 100°C depending on the type and moisture content.

Fisher Reagent Grade ammonium nitrate is slightly less hygroscopic than other ammonium nitrates in the static test. Specification Grade was second best. It appears that the ability to attract moisture may be proportional to the impurities in ammonium nitrate. Fisher Reagent Grade also dehydrated faster than the other in one test and Gulf Oil Low Density Prills did in the other. The Fisher type was not tested in the dynamic test. The results for the dynamic test for hygroscopicity appear similar to those for the static test at an average hygroscopicity of 80%. However, at an average hygroscopicity of 90%, the Specification Grade with clays added absorbed less moisture over two hours than did all the others in the dynamic test. Mississippi Ground Prills also came close to the clays, but the other three AN types were decidedly more hygroscopic (Figure 16).

The dynamic test may differ from the static test via the mechanism of absorption. The static test depends on the ability of the ammonium nitrate to attract water molecules. The dynamic test depends on the amount of moisture which the surface of the ammonium nitrate can absorb, as the moisture-ladened air is continuously passed over the surface of the chemical.

Experimental Procedure

Procedures followed in the dynamic test for 0-2 hours were:

Two-gram samples were weighted in jars which were 2 inches wide and 2 inches high. They were dried for two days at 100°C, cooled in a dessicator, weighed, and tightly closed; placed inside a chamber where temperature and humidity were controlled; opened, weighed and exposed to conditions in the chambers; weighed every 15-20 minutes thereafter inside this chamber.

Procedures followed in the static test are generally similar to those in Reference 1. 5-gram samples were weighed in cups 2-1/2 inches wide and 1/2 inches high. They were placed in dessicators in which chemical solutions controlled the RH. These samples were covered and removed from the dessicators at fixed periods of at least two hours, weighed, and returned to the dessicators.

The relative hygroscopicity was determined by dividing the weight increase by the original weight of ammonium nitrate sample.

$$\% \text{ Hygroscopicity} = \frac{\text{weight of water gained X 100}}{\text{dry weight of ammonium nitrate sample}}$$

REFERENCE

Military Standard 650, Explosive Sampling, Inspection, and Testing, U.S. Government Printing Office, Washington, 3 August 1962.

APPENDICES

APPENDIX A

Tables

TABLE 1

STATIC TEST I

% Hygroscopicity at 30°C &
% Dehydration at 100°C of Ammonium Nitrate
Samples

Relative Humidity %	Exposure Time Hours	60%	70%	80%	90%	95%
A. Specification Grade with 0.6% Microcell E (Calcium Silicate)						
1. % Hygroscopicity	2½	0.39	0.46	0.64	0.81	0.79
	4½	0.51	0.64	0.99	1.52	1.58
	6½	0.60	0.78	1.22	2.08	2.31
	24	2.02	3.12	4.47	9.32	12.07
2. % Dehydration	½	0.26	0.40	0.66	2.52	3.46
	1	0.10	0.13	0.28	1.35	2.41
B. Mississippi Ground Prills						
1. % Hygroscopicity	2½	0.10	0.17	0.33	0.67	0.69
	4½	0.17	0.28	0.65	1.41	1.60
	6½	0.22	0.39	0.84	2.08	2.44
	24	1.58	2.83	1.13	10.65	10.34
2. % Dehydration	½	0.34	0.50	0.61	2.54	2.10
	1	-0.70	0.21	0.26	1.84	1.11
C. Specification Grade with 0.6% Clay (Aluminum Silicate)						
1. % Hygroscopicity	2½	0.30	0.21	0.42	0.79	0.86
	4½	0.49	0.30	0.79	1.61	2.02
	6½	0.61	0.37	1.83	2.51	3.13
	24	2.01	3.28	5.31	13.84	17.02
2. % Dehydration	½	0.19	0.43	0.49	0.58	0.32
	1	0.11	0.19	-.20	0.12	0.01

Relative Humidity % / Exposure Time Hours		60%	70%	80%	90%	95%
D. Gulf Low Density Prills	2½	0.11	0.27	0.38	0.68	0.82
1. % Hygroscopicity	4½	0.18	0.29	0.63	1.42	1.86
	6½	0.14	0.36	0.84	2.23	2.97
	24	0.87	3.83	5.13	12.03	16.31
2. % Dehydration	½	.11	0.84	0.63	0.81	0.79
	1	0.06	0.43	0.23	0.20	0.17
E. Specification Grade						
1. % Hygroscopicity	2½	0.06	0.08	0.22	0.55	0.68
	4½	0.07	0.10	0.41	1.14	1.49
	6½	0.06	0.14	0.57	1.74	2.35
	24	0.52	2.43	3.91	9.06	13.21
2. % Dehydration	½	0.15	0.44	0.43	1.20	4.07
	1	0.09	0.18	0.18	0.54	1.32
F. Ketona High Density Prills	2½	0.23	0.27	0.41	0.75	0.82
1. % Hygroscopicity	4½	0.30	0.32	0.63	1.37	1.44
	6½	0.29	0.35	0.77	2.01	2.40
	24	1.27	2.74	4.15	10.51	13.02
2. % Dehydration	½	0.11	0.24	0.32	0.97	3.75
	1	0.06	0.00	0.12	0.45	1.92

TABLE 2

DYNAMIC TEST

% Hygroscopicity at 28°C
at Relative Humidity Levels of
76-84% C
87-94%

Ammonium Nitrate Type	Explosure Time Minutes	Sample 1 RH 76-84%	Sample 2 RH 76-84%	Sample 3 RH 87-94%	Sample 4 RH 87-94%
A. Mississippi Ground Prills % Hygroscopicity	15	1.10	1.42	2.14	0.95
	30	1.93	2.64	3.34	1.40
	45	2.93	3.65	4.17	1.93
	60	3.85	4.67	4.75	2.99
	75	4.48	5.53	5.83	3.18
	90	5.17	6.18	6.63	4.36
	105	5.72	6.79	7.25	4.94
	120	6.29	7.29	7.93	5.54
B. Specification Grade	15	1.20	1.06	1.16	2.15
	30	2.13	1.96	2.03	3.53
	45	3.14	2.92	3.05	4.81
	60	4.25	3.91	3.46	6.20
	75	5.10	4.68	4.09	6.80
	90	5.72	5.36	4.83	8.22
	105	6.31	5.90	5.29	8.87
	120	6.75	6.41	5.95	9.50
C. Ketona High Density Prills	15	0.98	1.06	1.04	2.00
	30	1.78	1.96	1.51	3.66
	45	2.51	2.92	2.74	4.96
	60	3.26	3.91	3.28	6.35
	75	3.95	4.68	3.83	7.53
	90	4.46	5.36	4.82	8.53
	105	5.01	5.90	5.46	9.28
	120	5.41	6.41	6.42	10.10

Ammonium Nitrate Type	Exposure Time Minutes	Sample 1 RH 76-84%	Sample 2 RH 76-84%	Sample 3 RH 87-94%	Sample 4 RH 87-94%
D. Gulf Oil Low Density Prills	15	0.88	1.05	0.93	2.51
	30	1.83	2.28	1.94	4.75
	45	2.63	3.23	2.75	7.24
	60	3.39	4.30	3.20	8.49
	75	4.13	5.08	3.99	9.76
	90	4.58	5.79	4.69	11.20
	105	5.06	6.38	5.18	13.10
	120	5.48	6.88	5.98	14.70
E. Specification Grade with 1.3% AC-10 Clay	15	1.31	1.18	1.43	1.01
	30	2.47	2.34	3.15	1.96
	45	3.56	3.54	3.97	2.90
	60	4.53	4.67	4.56	3.40
	75	5.20	5.37	5.47	4.45
	90	5.96	6.24	6.07	5.13
	105	6.53	6.91	6.66	5.76
	120	7.12	7.55	7.34	6.49
F. Specification Grade with 0.6% Microcell E	15	1.64	1.23	0.88	1.71
	30	2.62	2.14	1.71	2.76
	45	3.72	3.13	2.71	3.94
	60	4.80	3.97	3.17	4.75
	75	5.48	4.50	4.05	5.44
	90	6.23	5.20	4.58	6.47
	105	6.81	5.69	5.12	7.22
	120	7.48	6.29	5.90	8.21

TABLE 3

STATIC TEST II

% Hygrosopicity at 30°C &
% Dehydration of Ammonium Nitrate at 100°C
Samples

Relative Humidity %	Exposure Time Hours	60%	70%	80%	90%	95%
A. Ketona High Density Prills						
1. % Hygroscopicity	2	3.41	2.18	2.98	2.41	2.71
	24	11.91	7.33	12.94	13.99	18.25
	48	12.71	10.81	18.85	23.82	32.17
	72	13.33	14.27	24.86	33.82	46.29
	144	16.12	26.07	45.26	62.85	80.00
	163	16.67	28.78	49.99	68.26	84.44
2. % Dehydration	1	1.12	1.63	3.05	6.85	10.85
	2	0.08	0.67	0.34	0.30	1.27
B. Specification Grade	2	3.12	2.57	2.71	2.85	3.00
1. % Hygroscopicity	24	10.17	7.84	13.53	16.76	19.49
	48	11.03	11.59	19.62	28.03	34.17
	72	11.80	15.26	25.93	39.35	48.94
	144	15.02	27.85	46.95	68.70	83.96
	163	15.62	30.80	51.69	74.20	91.15
2. % Dehydration	1	0.38	0.62	1.08	8.24	10.34
	2	0.00	-0.04	0.07	0.12	0.15
C. Fisher Reagent Grade	2	3.58	2.19	2.78	2.33	2.67
1. % Hygroscopicity	24	9.79	6.87	13.93	14.27	17.83
	48	10.38	16.20	20.02	23.66	31.27
	72	11.11	13.47	26.28	33.19	45.01
	144	13.83	24.59	46.99	61.45	80.28
	163	14.42	27.25	51.76	67.05	87.41
2. % Dehydration	1	0.29	0.52	0.34	1.42	2.60
	2	-0.02	-0.02	-0.07	0.15	0.80

TABLE 4

SPECIFICATION REQUIREMENTS OF AMMONIUM NITRATE SAMPLES

	Gulf Oil Prills	Specification Grade	Fisher Reagent Grade	Hercules and Ketona Prills	Mississippi Prills
Chloroform soluble material %	.13	No test	No test*	.08	No analysis but it contains .2% boric acid, .2% ammonium acid phosphate and .01% diammonium sulfate
Ether soluble material %	No test*	.15 max	No test*	No	
Water insoluble material %	.48	.18 max	No test*	1.78	
Acidity as nitric acid %	.05	.02 max	*ph ~~9.5-60~~ 5.9-6.0	.03	
Nitrites %	None	None	None	None	
Sulfates %	<.02	.02	.001	.02	
Chlorides %	<.02	.02 max	.0005	.02	
Ammonium Nitrate %	98.6	.99 min	.992 min	97.2	
Heavy Metal %	*	*	.005 max	*	
Diatomacous Earth Coating %				1.73	
Sulfonate of Dimethyl Napthalene Coating %	.06				
Density grams/cc	1.61	1.63 max	*	1.59	
Moisture %	.02	.15 max	*	.06	

Microcell E is composed of mostly of calcium silicate
AC-10 is composed mostly of aluminum silicate
were added to specification grade for test * No test

APPENDIX B

Figures

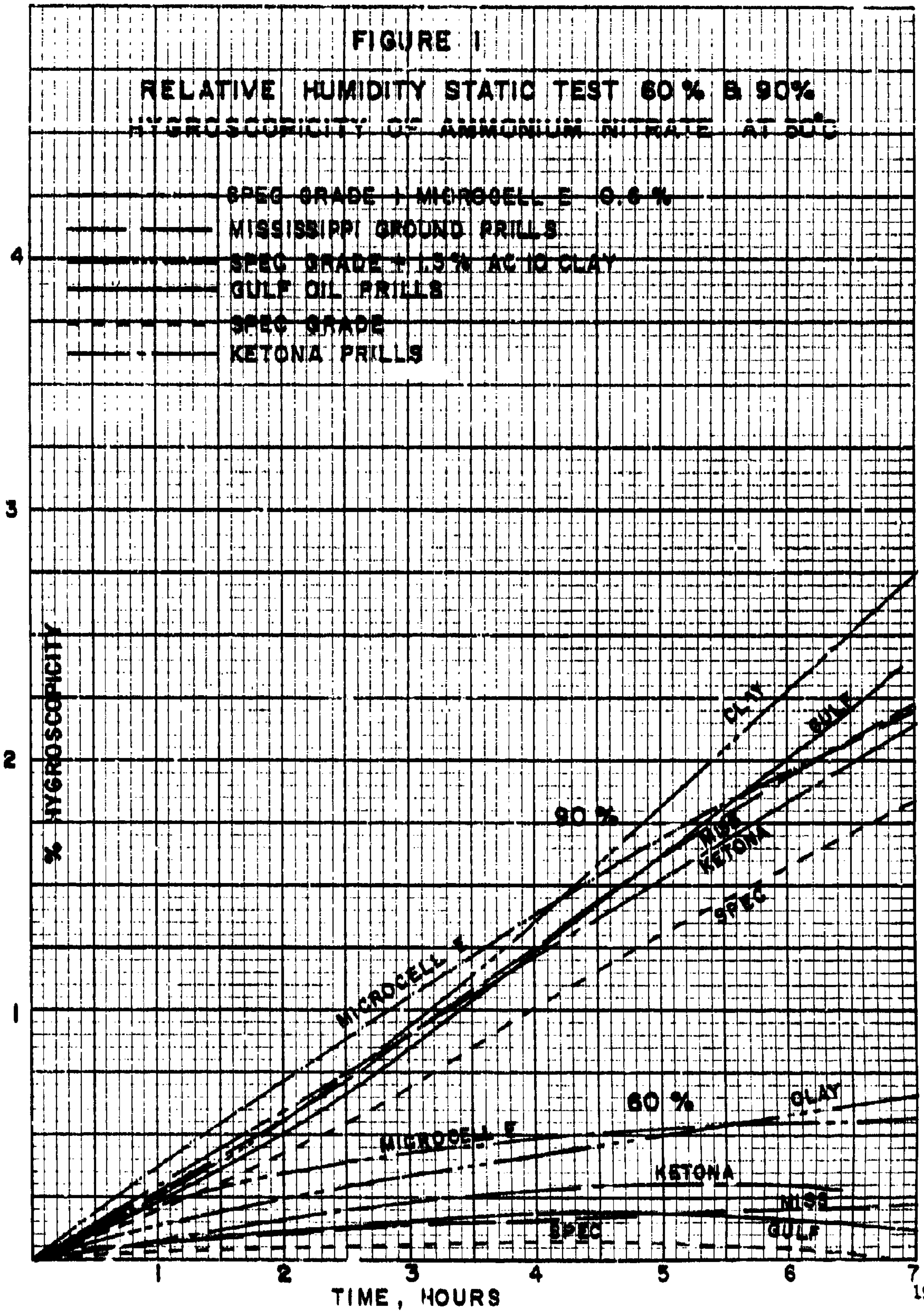

FIGURE I
RELATIVE HUMIDITY STATIC TEST 60 % & 90%
SPEC GRADE + MICROCELL E 0.6 %
MISSISSIPPI GROUND PRILLS
SPEC GRADE + 1.3 % AC 10 CLAY
GULF OIL PRILLS
SPEC GRADE
KETONA PRILLS
% HYGROSCOPICITY
TIME, HOURS
90 %
60 %
CLAY
GULF
MISS
KETONA
SPEC
MICROCELL E

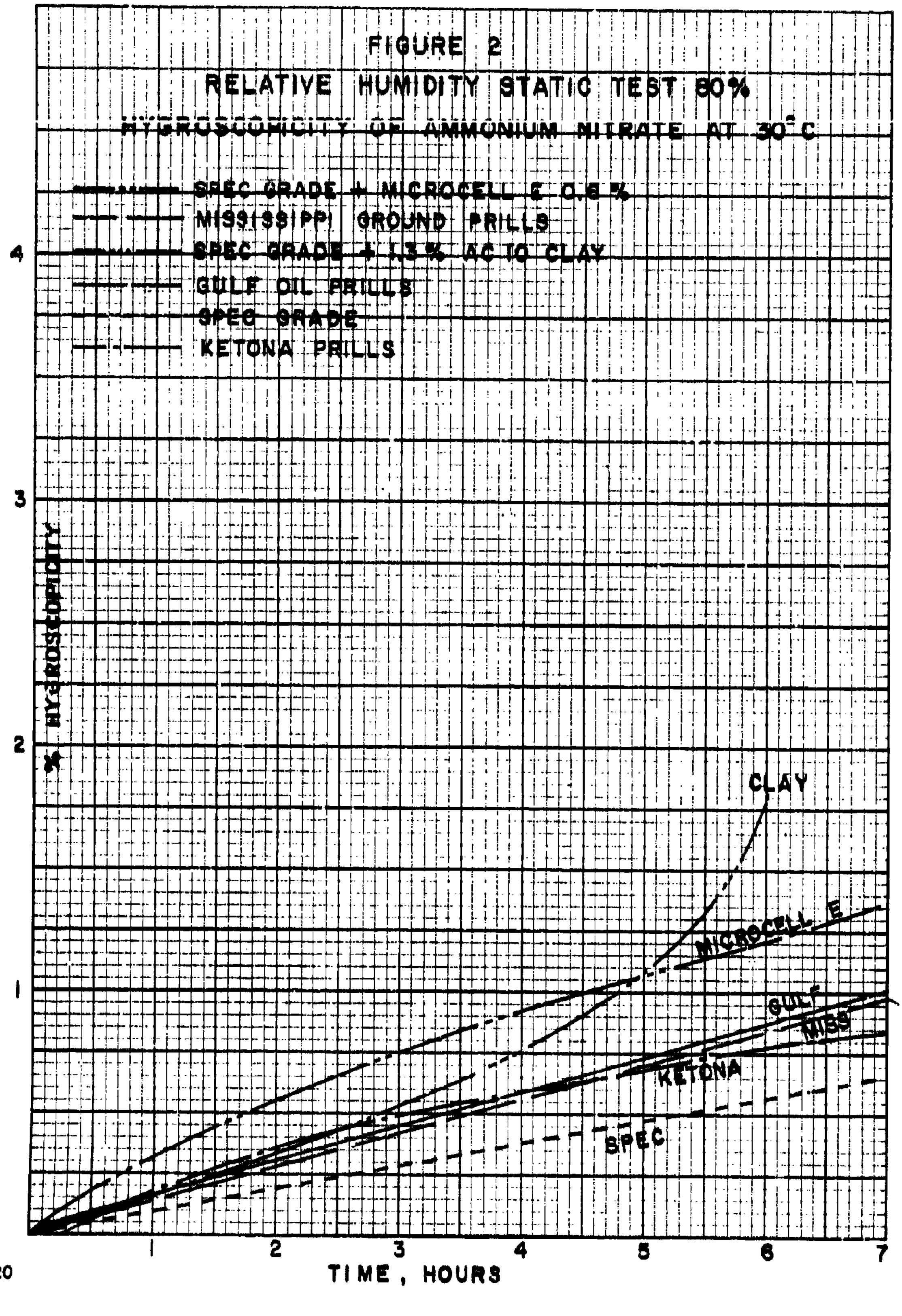
FIGURE 2
RELATIVE HUMIDITY STATIC TEST 80%
HYGROSCOPICITY OF AMMONIUM NITRATE AT 30°C
SPEC GRADE + MICROCELL E 0.5 %
MISSISSIPPI GROUND PRILLS
SPEC GRADE + 1.3 % AC TO CLAY
GULF OIL PRILLS
SPEC GRADE
KETONA PRILLS
CLAY
MICROCELL E
GULF
MISS
KETONA
SPEC
% HYGROSCOPICITY
1
2
3
4
1
2
3
4
5
6
7
TIME, HOURS

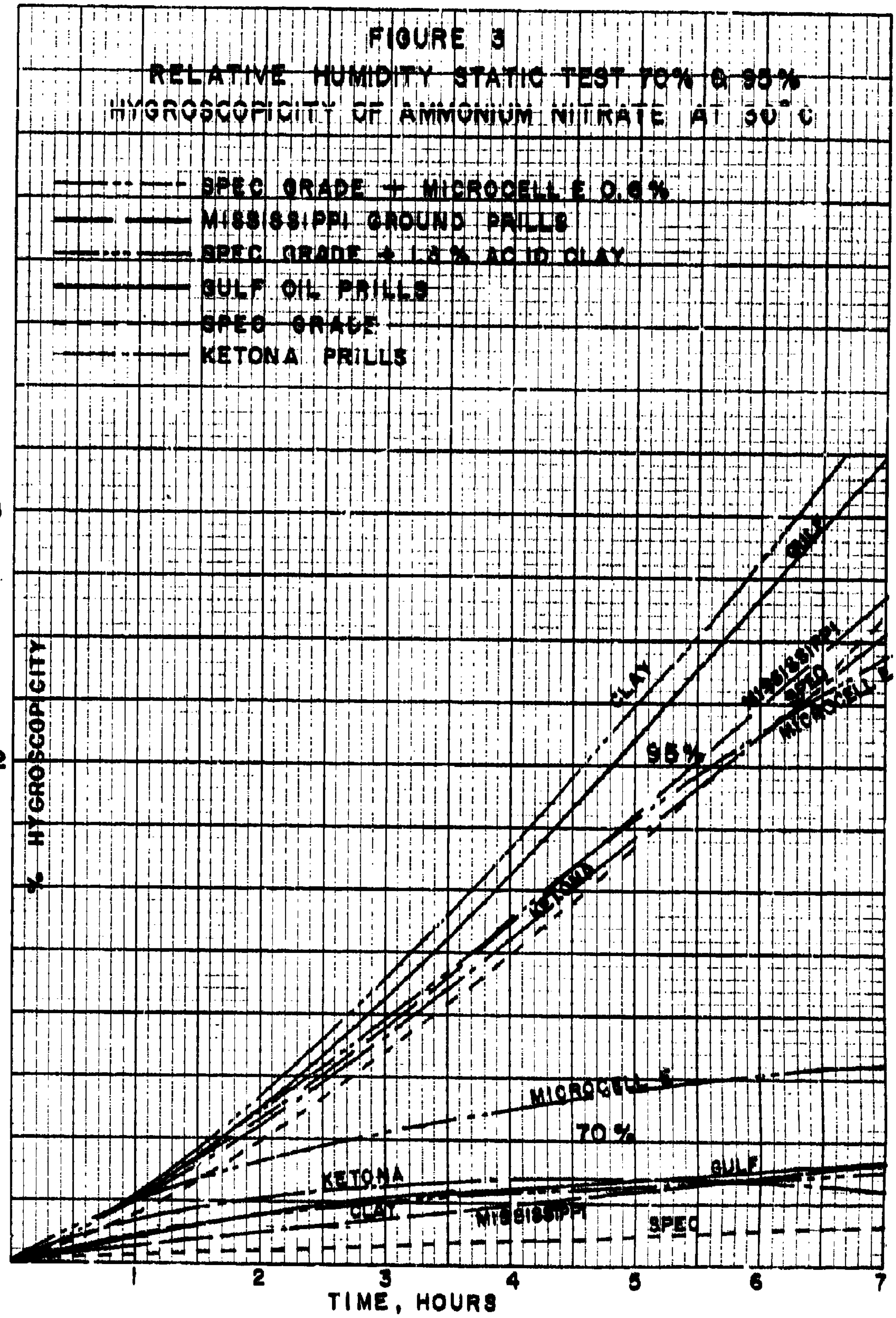
FIGURE 3
RELATIVE HUMIDITY STATIC TEST 70% & 95%
HYGROSCOPICITY OF AMMONIUM NITRATE AT 30° C
SPEC GRADE + MICROCELL E 0.6%
MISSISSIPPI GROUND PRILLS
SPEC GRADE + 1.5% ACID CLAY
GULF OIL PRILLS
SPEC GRADE
KETONA PRILLS
% HYGROSCOPICITY
4
3
2
1
CLAY
GULF
MISSISSIPPI
SPEC
MICROCELL E
95%
KETONA
MICROCELL E
70%
KETONA
GULF
CLAY
MISSISSIPPI
SPEC
1
2
3
4
5
6
7
TIME, HOURS

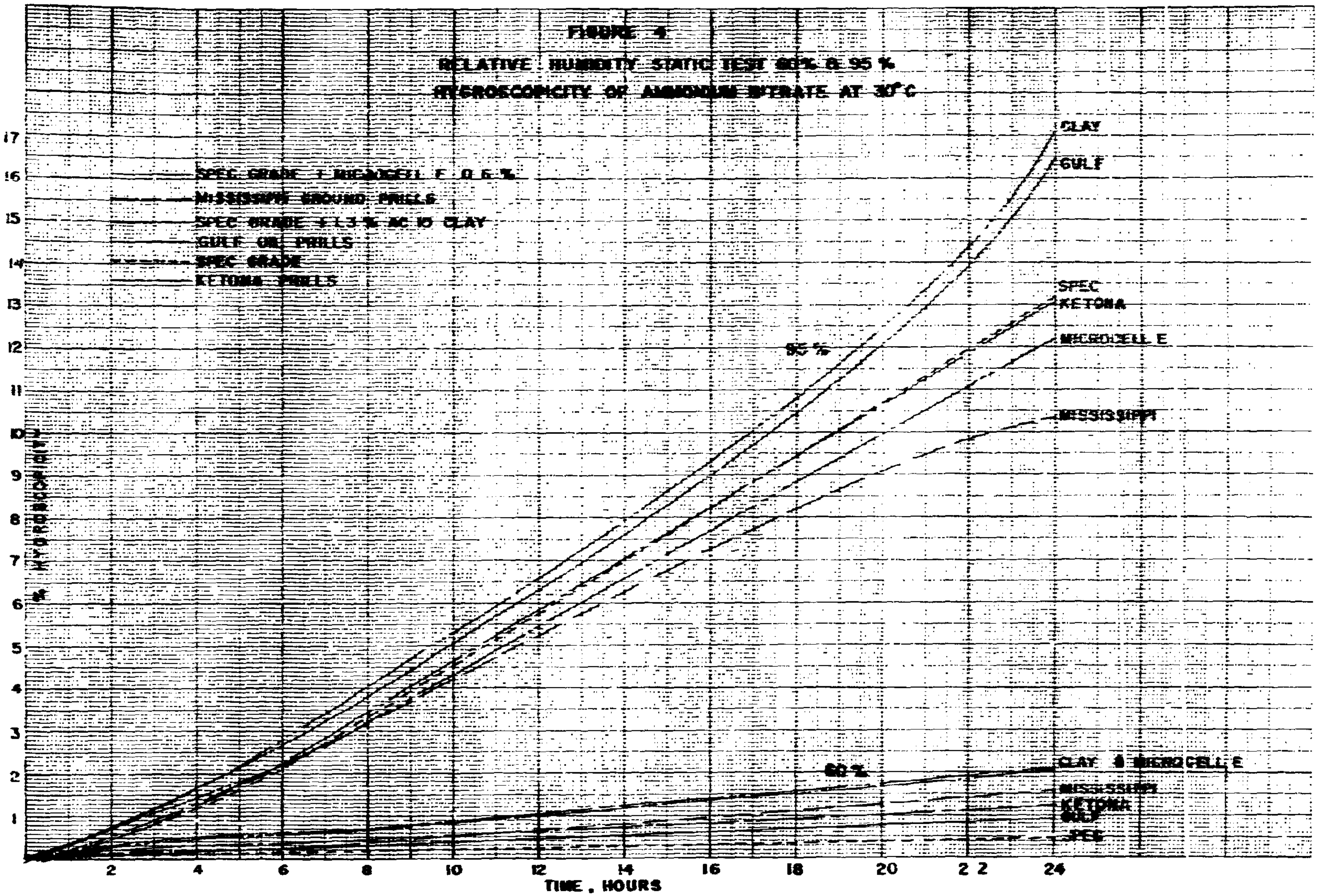
FIGURE 4
RELATIVE HUMIDITY STATIC TEST 80% & 95 %
HYGROSCOPICITY OF AMMONIUM NITRATE AT 30°C
SPEC GRADE + MICROCELL E 0.5 %
MISSISSIPPI GROUND PRILLS
SPEC GRADE + 1.3 % AC 10 CLAY
GULF OIL PRILLS
SPEC GRADE
KETONA PRILLS
CLAY
GULF
SPEC
KETONA
MICROCELL E
MISSISSIPPI
95 %
80 %
CLAY & MICROCELL E
MISSISSIPPI
KETONA
GULF
SPEC
% HYGROSCOPICITY
TIME, HOURS

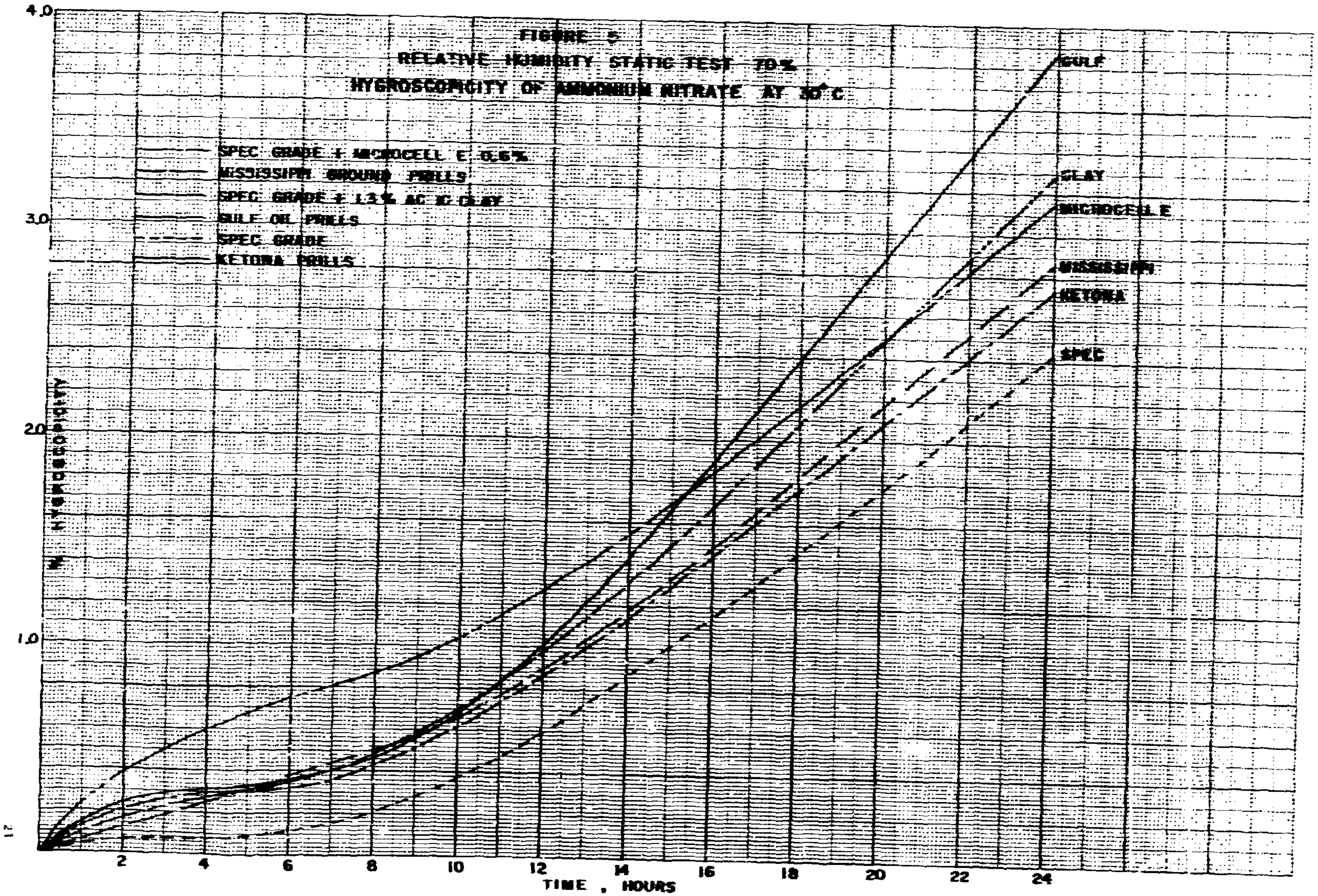
FIGURE 5
RELATIVE HUMIDITY STATIC TEST 70%
HYGROSCOPICITY OF AMMONIUM NITRATE AT 30°C
SPEC GRADE + MICROCELL E 0.6%
MISSISSIPPI GROUND PRILLS
SPEC GRADE + 1.3% AC IC CLAY
GULF OIL PRILLS
SPEC GRADE
KETONA PRILLS
GULF
CLAY
MICROCELL E
MISSISSIPPI
KETONA
SPEC
% HYGROSCOPICITY
4.0
3.0
2.0
1.0
2
4
6
8
10
12
14
16
18
20
22
24
TIME , HOURS

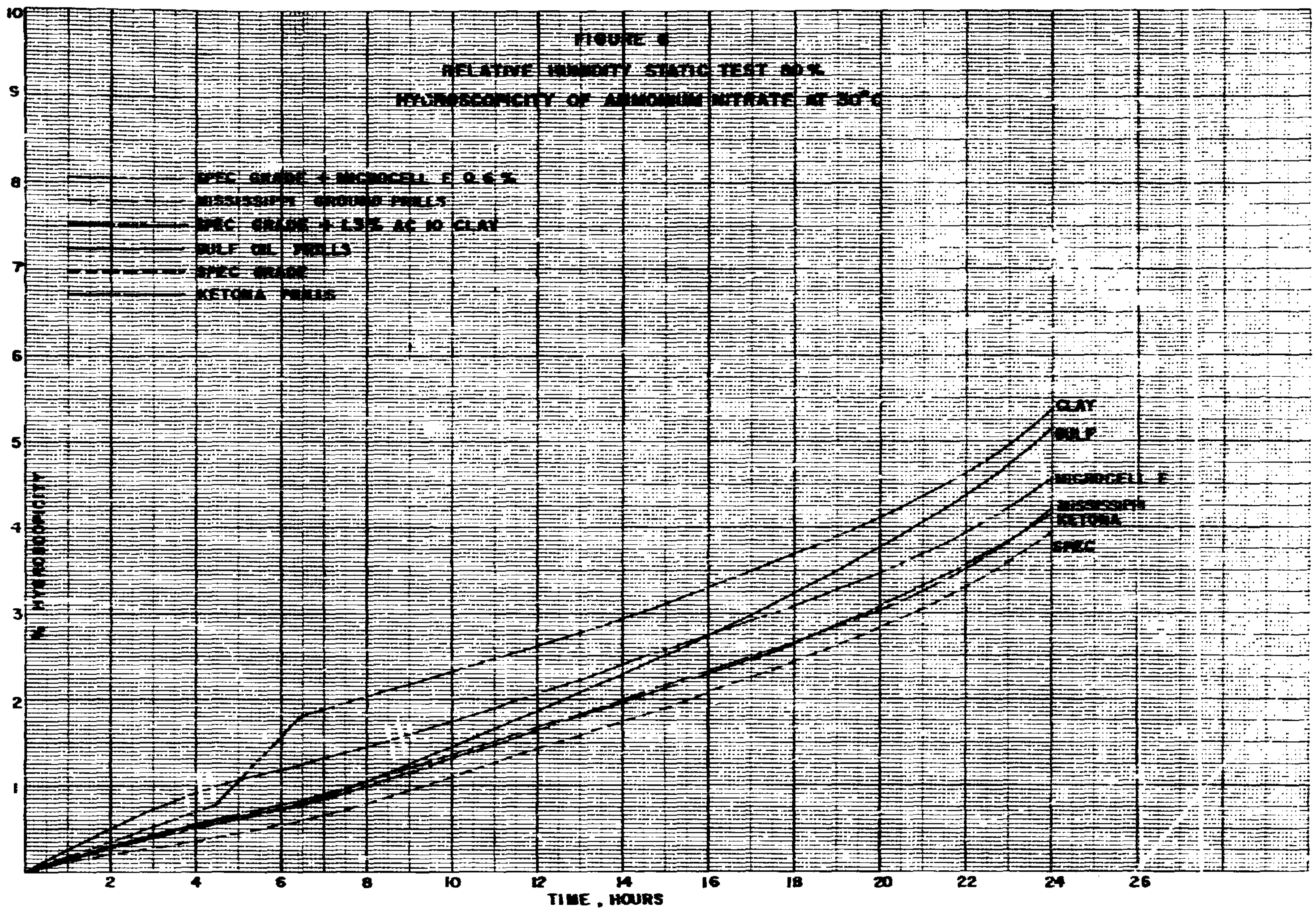

FIGURE
RELATIVE HUMIDITY STATIC TEST
HYGROSCOPICITY OF AMMONIUM NITRATE
SPEC GRADE + MICROCELL E 0.6 %
MISSISSIPPI GROUND PRILLS
SPEC GRADE + 1.5% AC 10 CLAY
GULF OIL PRILLS
SPEC GRADE
KETONA PRILLS
CLAY
GULF
MICROCELL E
MISSISSIPPI
KETONA
SPEC
% HYGROSCOPICITY
TIME , HOURS

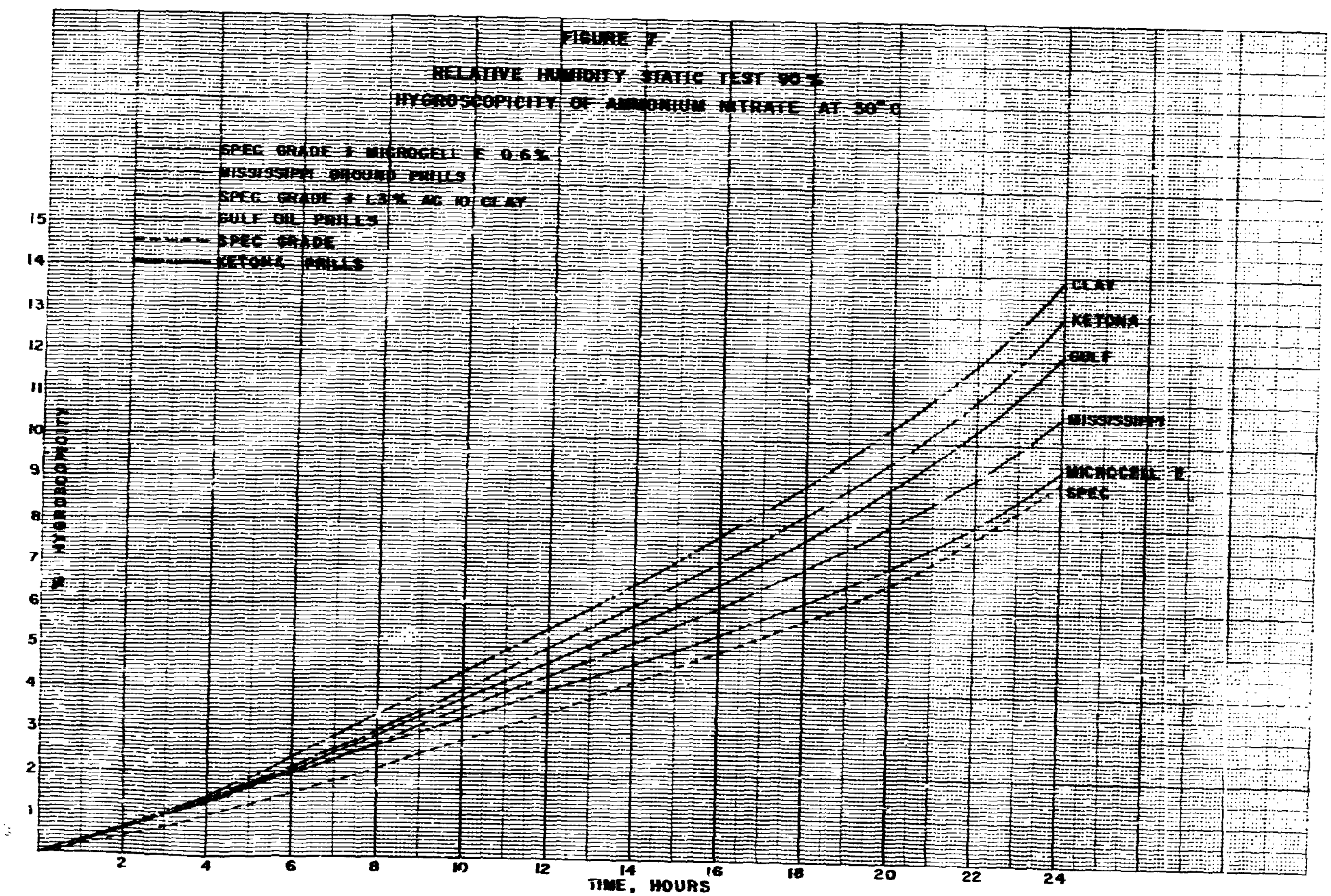
FIGURE 7
RELATIVE HUMIDITY STATIC TEST 90%
HYGROSCOPICITY OF AMMONIUM NITRATE AT 30° C
SPEC GRADE + MICROCELL E 0.6%
MISSISSIPPI GROUND PRILLS
SPEC GRADE + 1.3% AG 10 CLAY
GULF OIL PRILLS
SPEC GRADE
KETONA PRILLS
CLAY
KETONA
GULF
MISSISSIPPI
MICROCELL E
SPEC
% HYGROSCOPICITY
TIME, HOURS

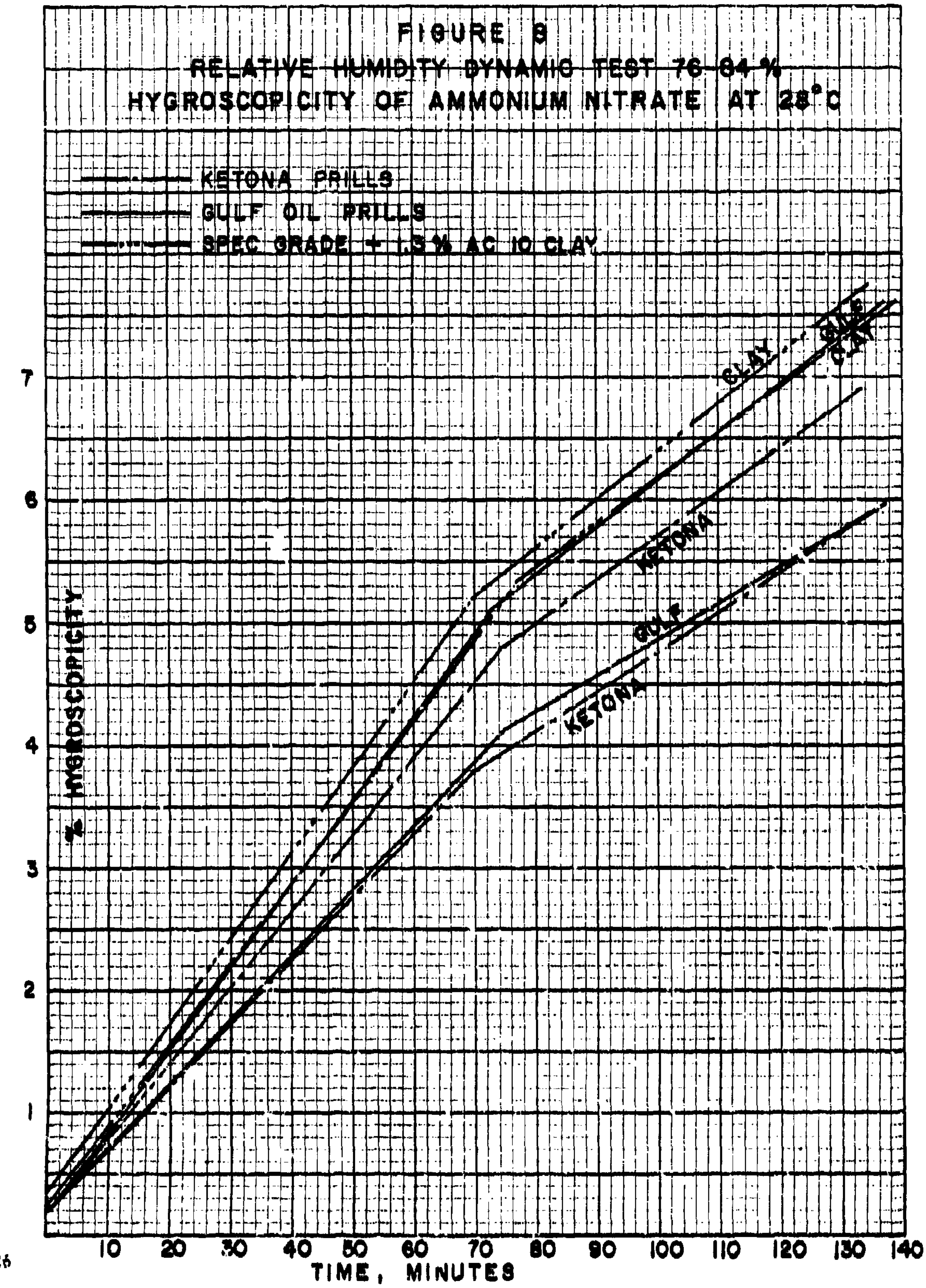

FIGURE 8
RELATIVE HUMIDITY DYNAMIC TEST 76-84 %
HYGROSCOPICITY OF AMMONIUM NITRATE AT 28°C

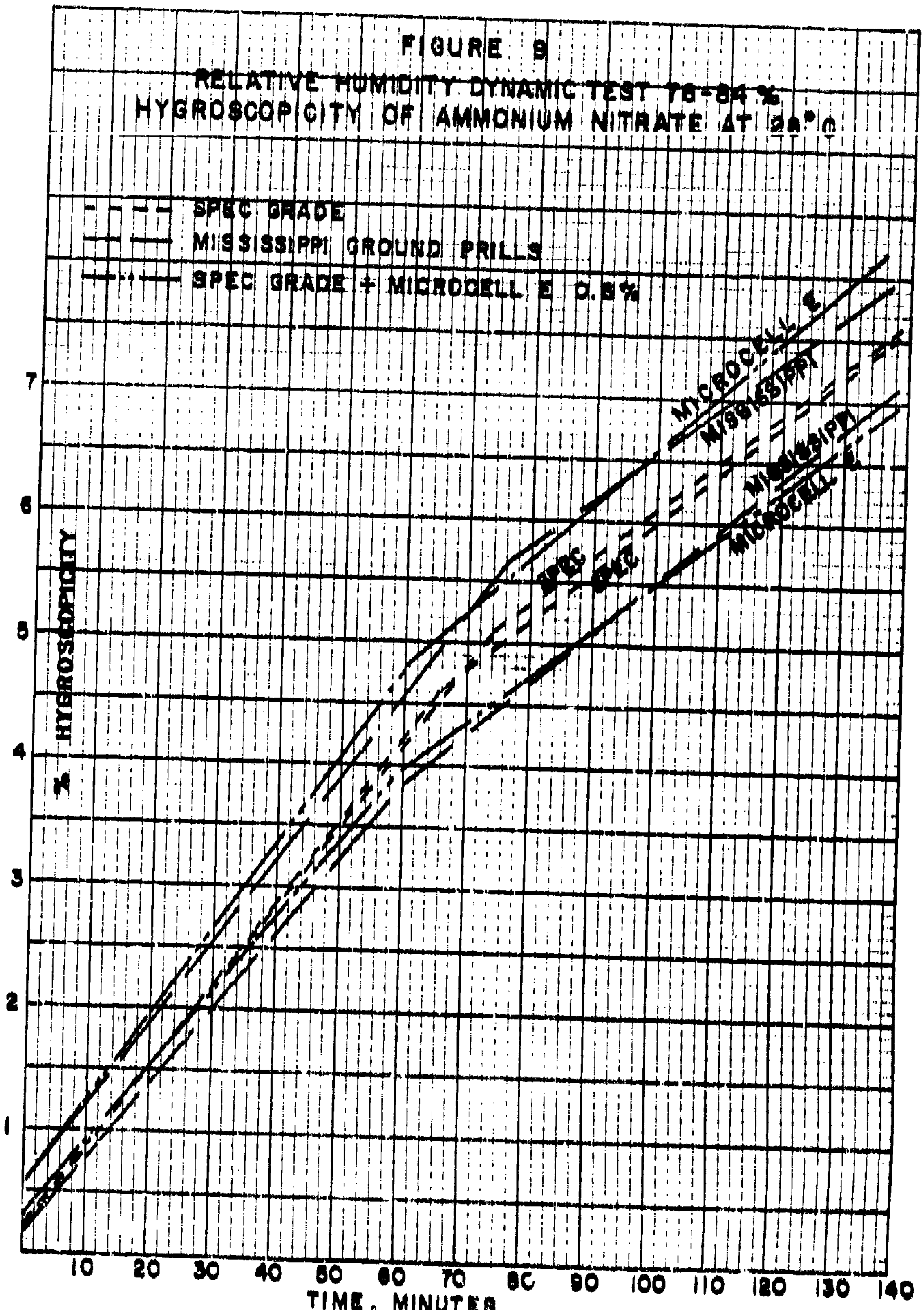
FIGURE 9
RELATIVE HUMIDITY DYNAMIC TEST 75-84 %
HYGROSCOPICITY OF AMMONIUM NITRATE AT 29°C
SPEC GRADE
MISSISSIPPI GROUND PRILLS
SPEC GRADE + MICROCELL E 0.5%
MICROCELL E
MISSISSIPPI
SPEC
GRADE
MISSISSIPPI
MICROCELL E
% HYGROSCOPICITY
TIME, MINUTES
1
2
3
4
5
6
7
10
20
30
40
50
60
70
80
90
100
110
120
130
140

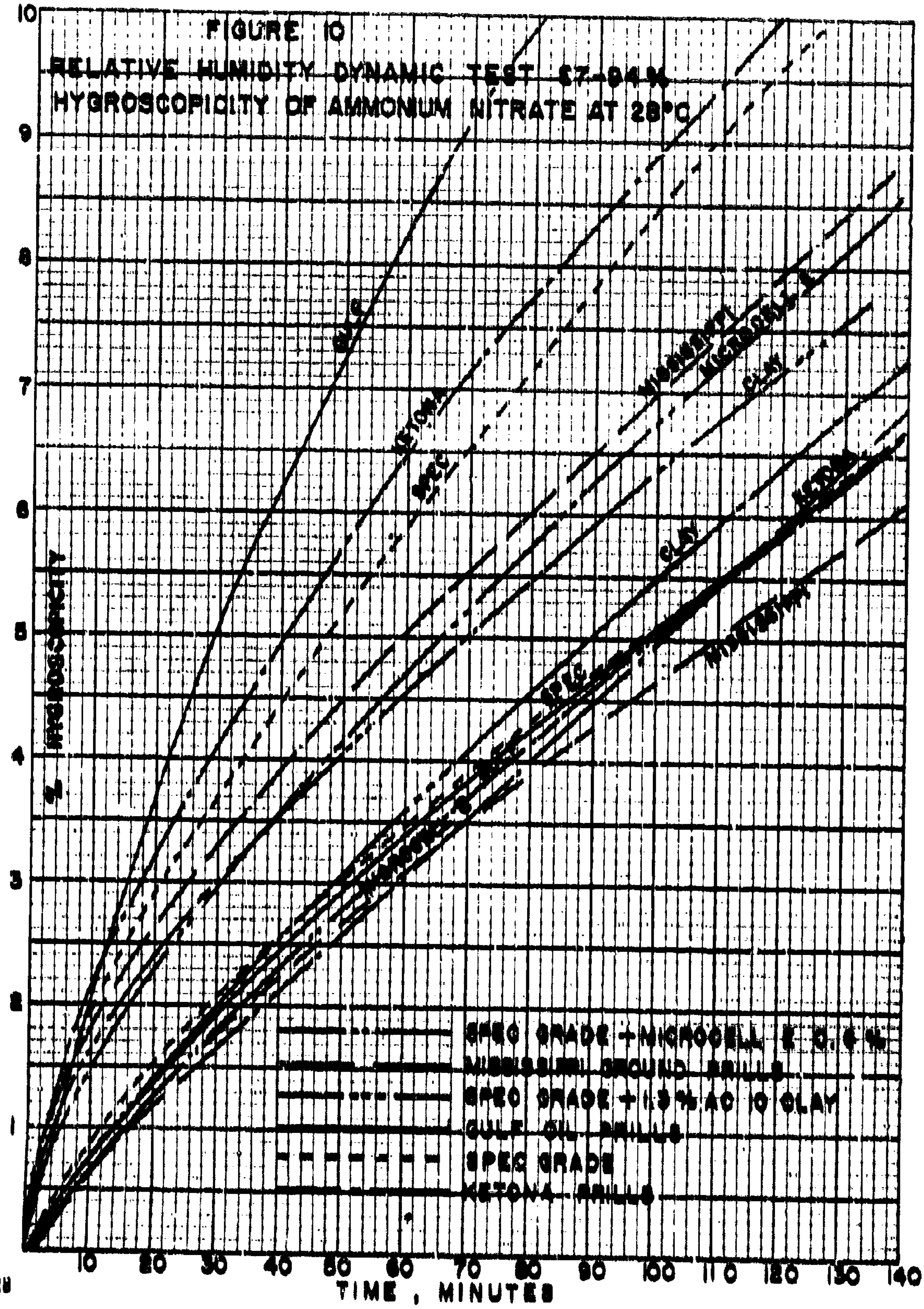

FIGURE 10
RELATIVE HUMIDITY DYNAMIC TEST 57-94%
HYGROSCOPICITY OF AMMONIUM NITRATE AT 28°C
% HYGROSCOPICITY
TIME, MINUTES
SPEC GRADE + MICROCELL E 0.6%
MISSISSIPPI GROUND PRILLS
SPEC GRADE + 1.3% AC 10 CLAY
GULF OIL PRILLS
SPEC GRADE
KETONA PRILLS
GULF
KETONA
SPEC
CLAY

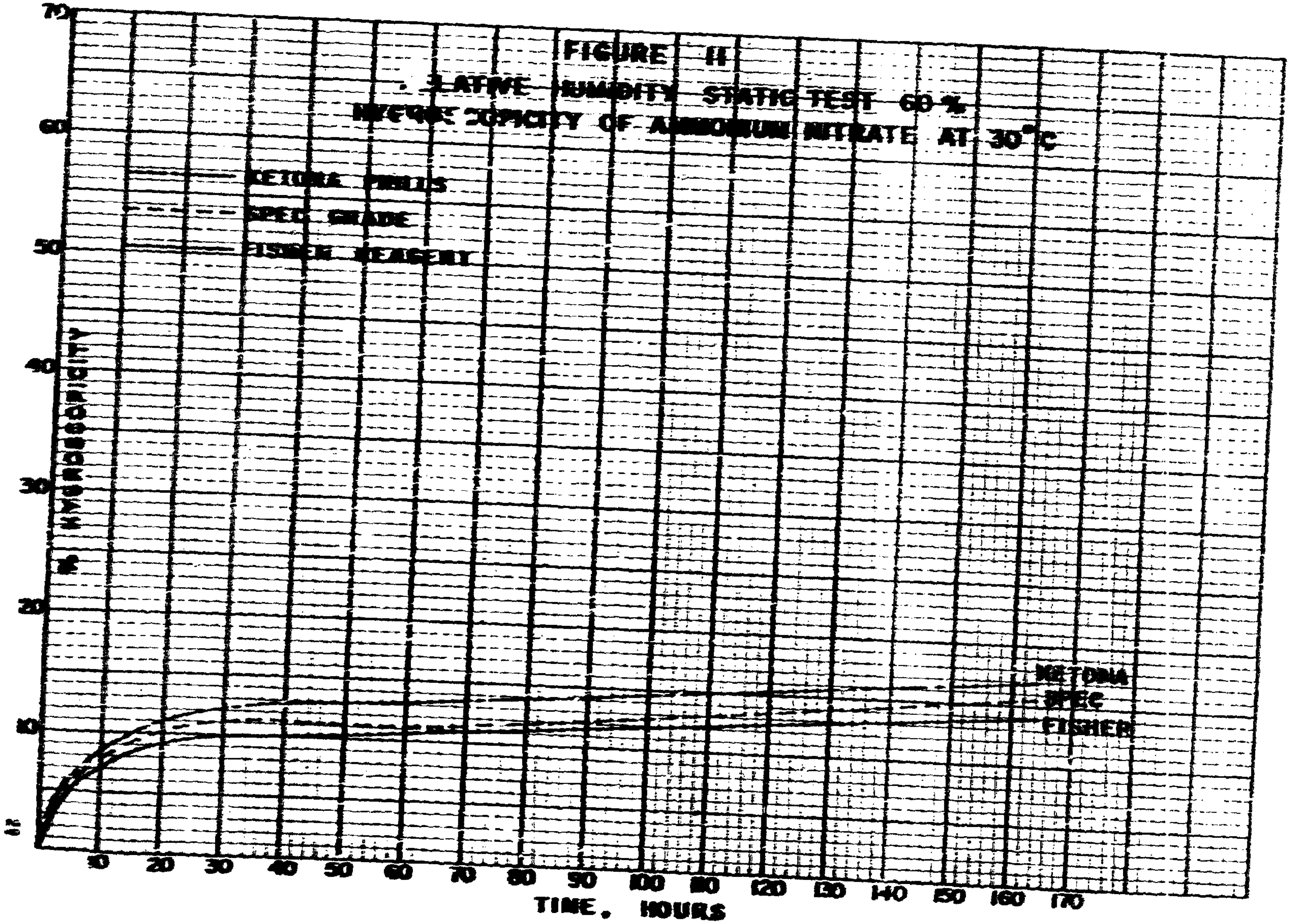

FIGURE II
RELATIVE HUMIDITY STATIC TEST 60 %
HYGROSCOPICITY OF AMMONIUM NITRATE AT 30°C
KETONA PRILLS
SPEC GRADE
FISHER REAGENT
KETONA
SPEC
FISHER
% HYGROSCOPICITY
70
60
50
40
30
20
10
0
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170
TIME, HOURS

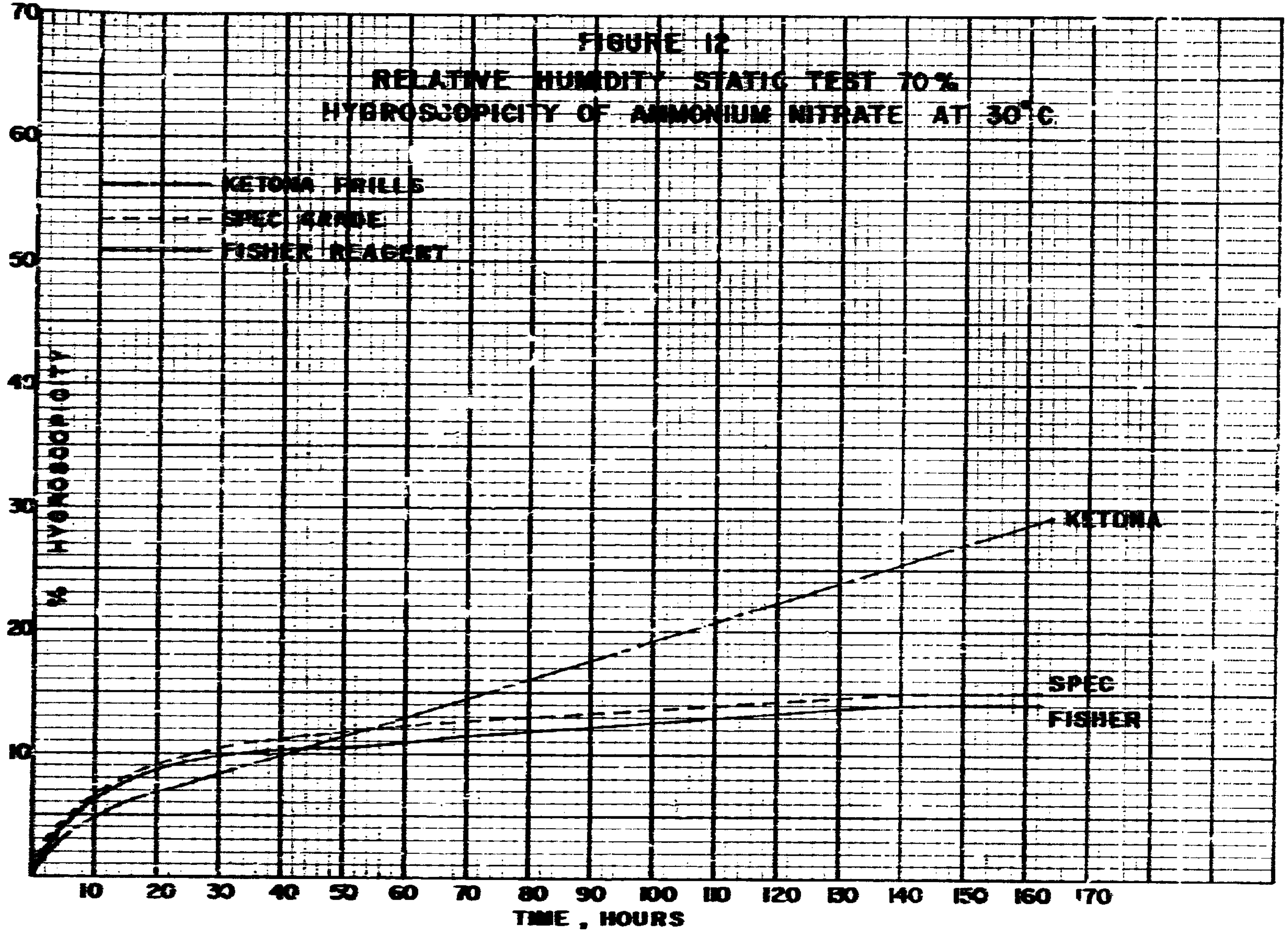

FIGURE 12
RELATIVE HUMIDITY STATIC TEST 70%
HYGROSCOPICITY OF AMMONIUM NITRATE AT 30°C

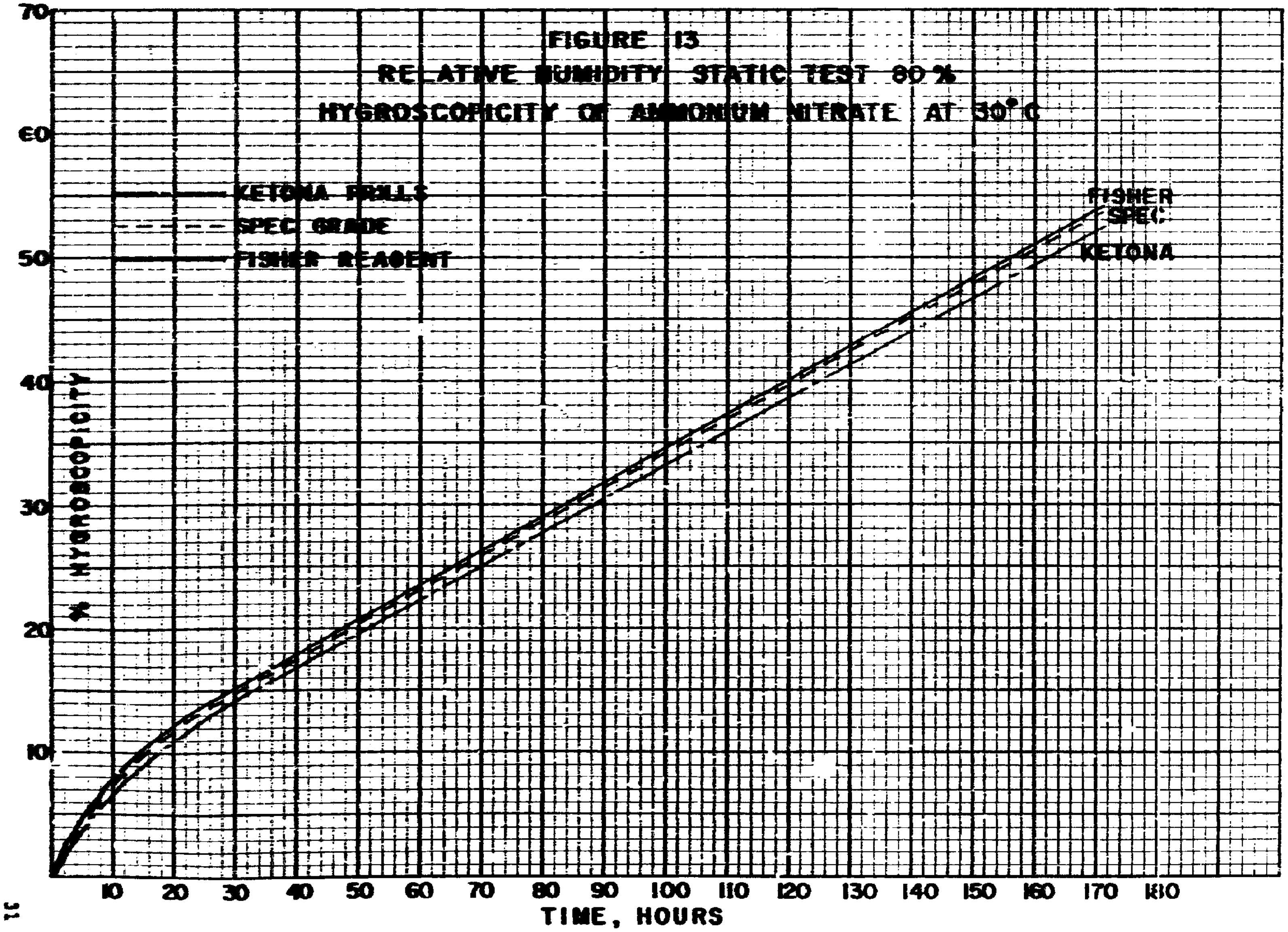

FIGURE 13
RELATIVE HUMIDITY STATIC TEST 80%
HYGROSCOPICITY OF AMMONIUM NITRATE AT 30°C

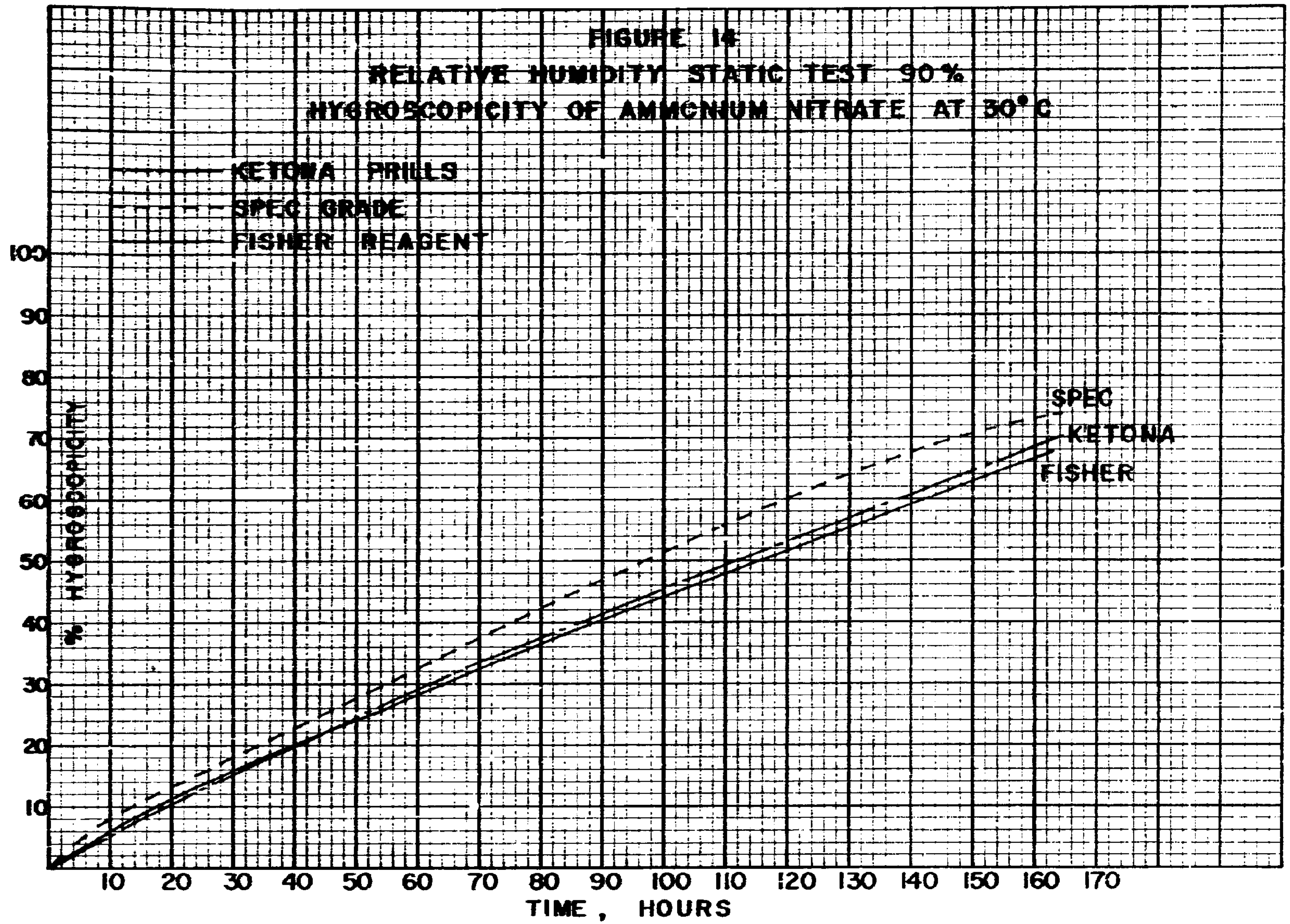
FIGURE 14
RELATIVE HUMIDITY STATIC TEST 90%
HYGROSCOPICITY OF AMMONIUM NITRATE AT 30° C
KETONA PRILLS
SPEC GRADE
FISHER REAGENT
SPEC
KETONA
FISHER
% HYGROSCOPICITY
10
20
30
40
50
60
70
80
90
100
TIME, HOURS
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170

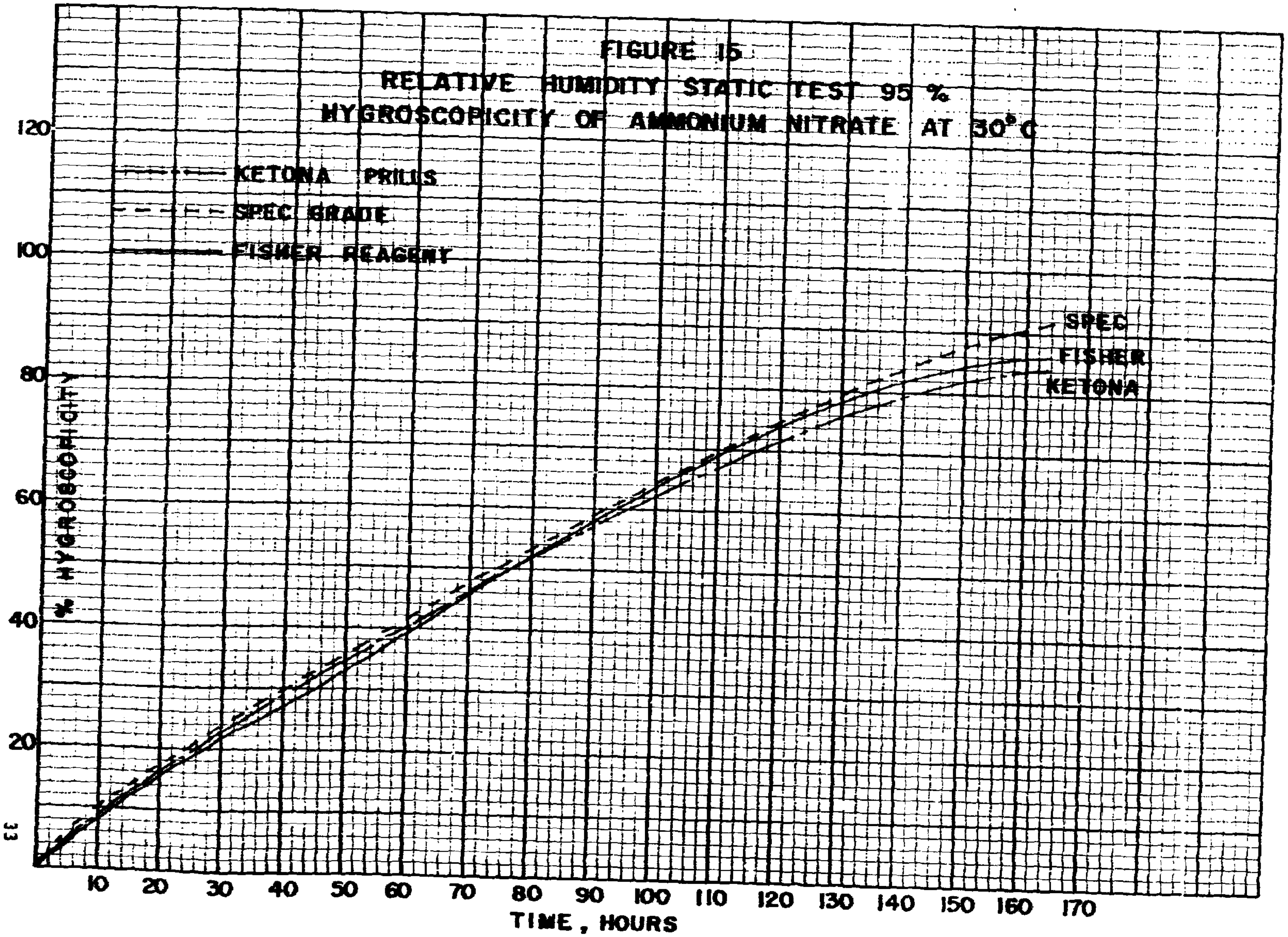

FIGURE 15
RELATIVE HUMIDITY STATIC TEST 95 %
HYGROSCOPICITY OF AMMONIUM NITRATE AT 30°C

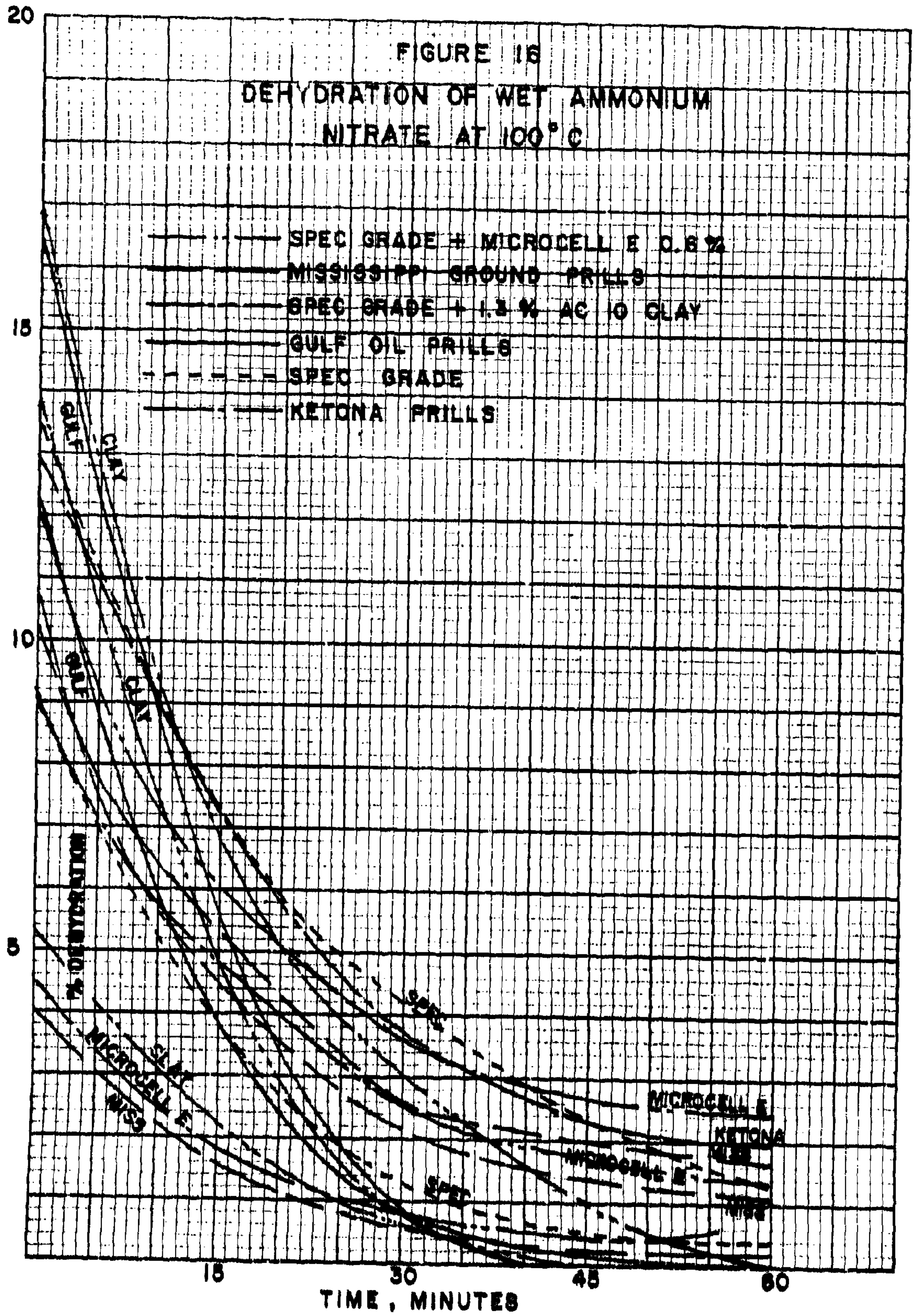

FIGURE 16
DEHYDRATION OF WET AMMONIUM NITRATE AT 100° C

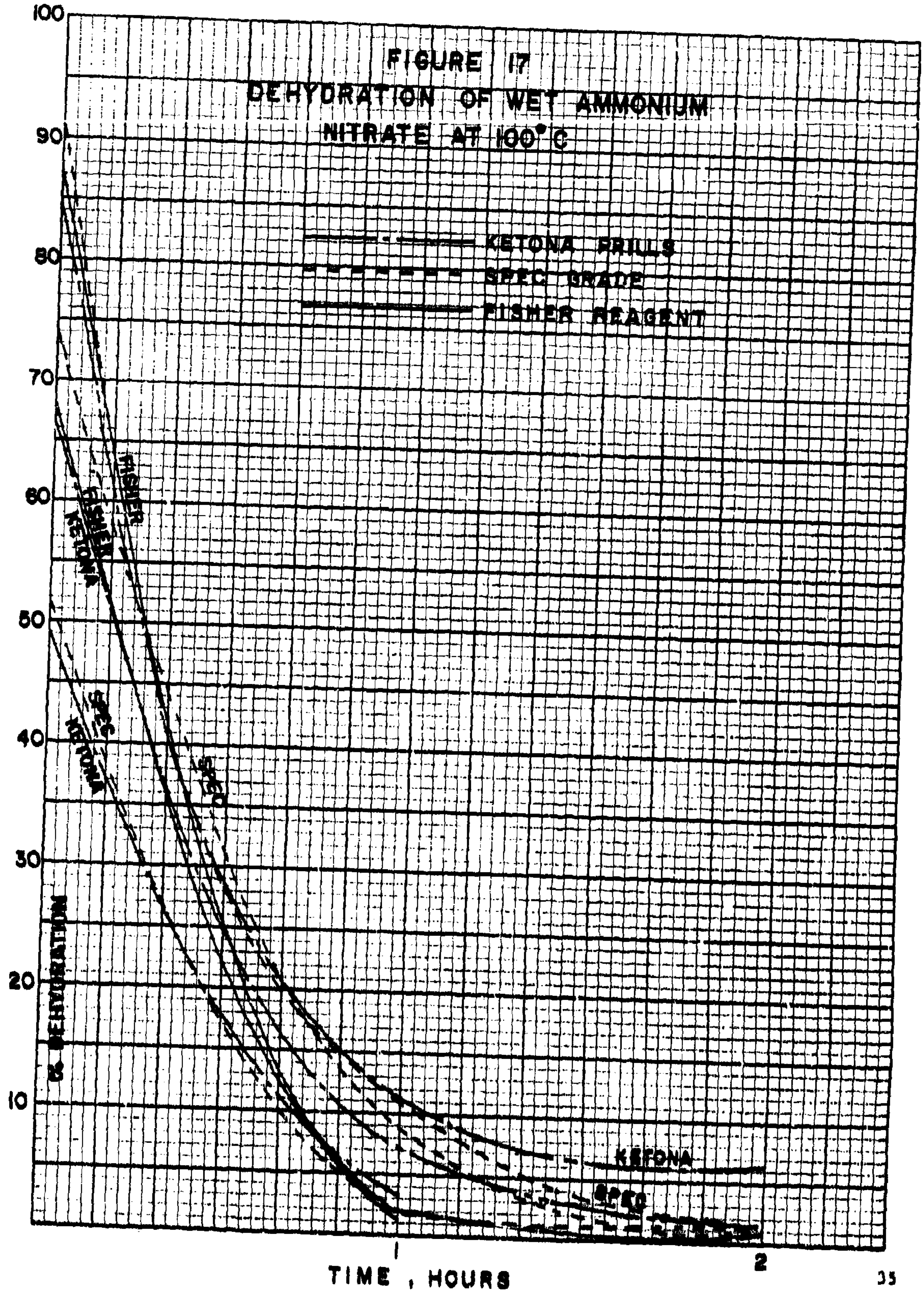
FIGURE 17
DEHYDRATION OF WET AMMONIUM NITRATE AT 100° C
KETONA PRILLS
SPEC GRADE
FISHER REAGENT
FISHER
KETONA
SPEC
% DEHYDRATION
TIME , HOURS
100
90
80
70
60
50
40
30
20
10
1
2

ABSTRACT DATA

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) Picatinny Arsenal Dover, New Jersey	2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED 2b. GROUP

3. REPORT TITLE

HYGROSCOPICITY OF AMMONIUM NITRATE SAMPLES

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

5. AUTHOR(S) (First name, middle initial, last name)

Joel Harris

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
April 1970	42	1

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S) Technical Report 4032
b. PROJECT NO.	
c.	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)
d.	

10. DISTRIBUTION STATEMENT

Statement 2 -- This document is subject to special export controls and each transmittal to foreign governments and foreign nationals may be made only with prior approval of Picatinny Arsenal.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Picatinny Arsenal U.S. Army Munitions Command Dover, New Jersey 07801

13. ABSTRACT

Ammonium nitrate is a component of many explosive systems, but a disadvantage in its use is its hygroscopicity. To extend the shelf life of explosives containing ammonium nitrate, it is important to minimize its hygroscopicity.

Samples of ammonium nitrate were tested by the Ammunition Engineering Directorate's Artillery Ammunition Laboratory for hygroscopicity at relative humidity levels of 60%, 70%, 80% and 90% and between 28-30°C. Most of the samples of ammonium nitrate were coated; some were manufactured by a process producing prills; clay material was added in two cases. The results indicated that the ammonium nitrate which contained the least amount of impurities or additives also was the least hygroscopic.

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Ammonium nitrate Hygroscopicity factor Minol II						